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(54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To eliminate visible dot and luminance unevennessand to suppress the occurrence of a moireby making the arrangement of dots satisfy a specified condition and using randomly arranged and formed members.
SOLUTION: A dot forming surface is divided into an area of a square of 1-4mm2and the dots are arranged to be formed so that a function G (R) obtained from arrangement of all dots existing in the area is 0<S1/S2<0.4 in the range of 3≤R/R0≤6. WhereR is distance from the central position of the dot to the central position of the other dotR0 is a value L/√ N dividing the length of one side of a square area by the square root of the number of dots N. The G (R) is the function obtained by calculating a weighted means of a dynamic size distributive function g (R) and approximating using a method of least squaresand S1 is the value obtained integrating |G (R)-(mean value of G (R)| by the R/R0and S2 is the value obtained by integrating the mean value of G (R) by the R/R0.

CLAIMS

[Claim(s)]
[Claim 1]A liquid crystal cell.
A subsurface illuminator which is arranged at the back of this liquid crystal celland contains a light guide plate at least.
Are the liquid crystal display provided with the aboveand an optical member arranged on the upper surface of the above-mentioned light guide platethe undersurfacethe upper surface of this light guide plateor the undersurface at least to either. Light A dot of reflectiondispersionrefractiondiffractionabsorptiona penetrationthe shape of heights polarized or deflectedor recessed shapeOr arrangement formation is carried out by dot which gave optical activitysuch as a dot which gave changeor an electrooptic effectto an optical propertyand in a field of not less than 80% of whole surface products of a forming face of this dot in the above-mentioned light guide plate or the above-mentioned optical member[divide the following conditionsi.e.a forming face of this dotinto square regions of 1-4 $mm^2$and / in these square regions]In the function G (R) acquired by weight averaging the radial distribution function g (R) according to an arrangement relation of a dot seen from this dot called for for every dotand approximating with the least square methodR/R0 in 3-6Distance to a center position of the other dot from the center position about 0<S1/S2<0.4however R:each dotR0 : A value and S1:R/R0 which broke a length of one side of these square regions by a square root of a dot number in these square regions within the limits of 3-6Arrangement formation of the above-mentioned dot was carried out so that it might be a function with which a value produced by integrating R/R0 with a difference with average value of G (R) and G (R) and a value from which S2:R/R0 is obtained by integrating R/R0 with average value of G (R) within the limits of 3-6 are filled.

[Claim 2]A liquid crystal cell.
A subsurface illuminator which is arranged at the back of this liquid crystal celland contains a light guide plate at least.
Are the liquid crystal display provided with the aboveand an optical member arranged on the upper surface of the above-mentioned light guide platethe undersurfacethe upper surface of this light guide plateor the undersurface at least to either. Light A dot of reflectiondispersionrefractiondiffractionabsorptiona penetrationthe shape of heights polarized or deflectedor recessed shapeOr arrangement

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[Claim 3]A liquid crystal cell.
A subsurface illuminator which is arranged at the back of this liquid crystal celland contains a light guide plate at least.
Are the liquid crystal display provided with the aboveand an optical member arranged on the upper surface of the above-mentioned light guide platethe undersurfacethe upper surface of this light guide plateor the undersurface at least to either. Light A dot of reflectiondispersionrefractiondiffractionabsorptiona penetrationthe shape of heights polarized or deflectedor recessed shapeOr arrangement formation is carried out by dot which gave optical activitysuch as a dot which gave changeor an electrooptic effectto an optical propertyand in a field of not less than 80% of whole surface products of a forming face of this dot in the above-mentioned light guide plate or the above-mentioned optical member[divide the following conditionsi.e.a forming face of this dotinto square regions of 1-4 mm^{2}and / in these square regions]In the function G (R) acquired by weight averaging the radial distribution function g (R) according to an arrangement relation of a dot seen from this dot called for for every dotand approximating with the least square methodR/R0 in 3-6Distance to a center position of the other dot from the center position about 0<S1/S2<0.02however R:each dotR0 : A value and S1:R/R0 which broke a length of one side of these square regions by a square root of a dot number in these square regions

within the limits of 3-6Arrangement formation of the above-mentioned dot was carried out so that it might be a function with which a value produced by integrating R/R0 with a difference with average value of G (R) and G (R) and a value from which S2:R/R0 is obtained by integrating R/R0 with average value of G (R) within the limits of 3-6 are filled.

[Claim 4]the liquid crystal display **** according to any one of claims 1 to 3 -- said function G (R). Average value of function [in the range of said R below G1/G2<0.95however the radius r of a circle of an area equal to an average of area of a G1:dot / said] G (R)G2: A liquid crystal display being a function by which said R fulfills average value of said function [in the range of 0 - 5xR0] G (R).
[Claim 5]the liquid crystal display **** according to any one of claims 1 to 3 -- said function G (R). Average value of function [in the range of said R below G1/G2<0.05however the radius r of a circle of an area equal to an average of area of a G1:dot / said] G (R)G2: A liquid crystal display being a function by which said R fulfills average value of said function [in the range of 0 - 5xR0] G (R).
[Claim 6]A liquid crystal display characterized by dot density of each subregion when the square regions are equally divided into four in a grid pattern being less than **20% of the average dot density of the square regions in the liquid crystal display according to claim 1 or 3 in said not less than 80% of square regions.
[Claim 7]A liquid crystal display characterized by diameters of circle of an area equal to area of said dot being 0.001 mm or more and 0.15 mm or less by said not less than 80% of dot in the liquid crystal display according to claim 13or 6.
[Claim 8]A liquid crystal display characterized by diameters of circle of an area equal to area of said dot being 0.01 mm or more and 0.05 mm or less by said not less than 80% of dot in the liquid crystal display according to claim 13or 6.
[Claim 9]In the liquid crystal display according to any one of claims 1 to 8in the range of R<Lysubstantially by G(R) =0. A liquid crystal display which two or more peaks exist in G (R)among those at least one exists in the range of Lx>R>Lyand is further characterized by those things [carrying out arrangement formation of this dotas struck and existed in at least one in the range of R>Lx]. Hereit is Lx. : They are width of a parallel dotand Ly to a light source. : It is the width of a vertical dot to a light source.
[Claim 10]being related with a size of a dot in the liquid crystal display according to any one of claims 1 to 9 -- not less than 80% of

dot -- Lx>Ly0.05 mm<Lx<1.0mmand 0.03 mm<Ly -- < -- a liquid crystal display coming outand carrying out arrangement formation of this dot 0.09 mm as it is.

[Claim 11]A liquid crystal display currently carrying out arrangement formation of this dot about a size of a dot in the liquid crystal display according to any one of claims 1 to 9 so that not less than 80% of dots may be Lx>Lyx20.1 mm<Lx<0.3mmand 0.03 mm<Ly<0.09mm.

[Claim 12]A liquid crystal display currently carrying out arrangement formation of this dot in the liquid crystal display according to any one of claims 1 to 11 that a dot area of not less than 80% of dot of more than 0.0001-mm^2 is below 0.09-mm^2.

[Claim 13]A liquid crystal display currently carrying out arrangement formation of this dot in the liquid crystal display according to any one of claims 1 to 12 so that it may be substantially set to G(R) =0 in the range of R< dot diameter.

[Claim 14]A liquid crystal display setting up arrangement of said dot using a random number in the liquid crystal display according to any one of claims 1 to 13.

[Claim 15]In the liquid crystal display according to any one of claims 1 to 14position shifted from a lattice point arranged regularly as a coordinates position of at least some said dots of said square regionsA liquid crystal display carrying out arrangement formation of said dot at random by setting up the position gap width using a random number.

[Claim 16]In the liquid crystal display according to any one of claims 1 to 14after determining a coordinates position of said dot using a random numberin the process to determine. By redetermining a coordinates position of said dot which eliminated only a coordinates position of a dot which a lap of a coordinates position of said dot and unusual contiguity have producedand eliminated a coordinates position using a random number newly generated after an appropriate timeA liquid crystal display carrying out arrangement formation of said dot without lapping at random and mutually.

[Claim 17]A liquid crystal display having divided the whole forming face of said dothaving set up subregion as a cell in the liquid crystal display according to claim 1415or 16and carrying out arrangement formation of said dot with said random number within this each cell.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the liquid crystal display which used devicessuch as a subsurface illuminator (back light).
[0002]
[Description of the Prior Art]In recent yearsthe miniaturization of a personal computer is promoted and the portable model called a laptop form has spread widely. In this laptop formalthough the liquid crystal display is usually used for that displaywith colored-presentation-izing in recent yearsa light source is allocated behind a liquid crystal display paneland the liquid crystal display of a backlighting form which illuminated the whole display surface from the back side is spreading. The light source as a subsurface illuminator of such a liquid crystal display has high luminositymoreover does not have the nonuniformity of luminosityand needs to illuminate the whole display surface. In order to raise luminositywhen raising the luminosity of the light sourceit was easybut in the personal computer of a laptop formetc.since the cell etc. were made into the driving sourceraising the luminosity of a light source has a limit from pointssuch as power consumptionand there was no effective method conventionally.
[0003]As a lighting system of the conventional edge light system for liquid crystal display elements which is indicated to JP4-162002A or JP6-67004AAs shown in drawing 33lampssuch as a cold cathode tube and a hot cathode tubeare used as the light source 1Allot this to the end face of the light guide plate 2 which consists of permeable materialsand the light reflector 4 made to reflect the light scattering layer 3 and light which scatter light over the undersurface of a light guide plate is formedThe diffusion board 5 which consists of a synthetic resin of the opalescence which has the light scattering effect for equalizing the luminosity of an illuminated face over the whole field on the upper surface of a light guide plate is formed. And furtherthe diffused light is converged to some extent on the upper surface of this diffusion boardand the condensing plates 6 and 7 of two sheets for raising the luminosity of the transverse plane of a display are arranged.
[0004]The light guide plate of the reflective **** method is also proposed in the light which formed the grating slot in the light guide plate bottomand entered into the light guide plate like JP7-294745A on the other hand.
[0005]As stated abovethe light emitted from the light source in the conventional lighting systemIt is led to a light guide plateis scattered about with the light scattering material contained in a light scattering

layerand has composition which passes a diffusion board after that and is irradiated by the liquid crystal elementand the composition is complicated and there is a problem of the brightness lowering by the loss of light scattering etc. There are problemslike metallic mold manufacture is difficult for the method which forms a grating slotand it has it.

[0006]

[Problem(s) to be Solved by the Invention]It aims at reduction of the part mark of this subsurface illuminatoror the number of assemblersand the improvement in the characteristicThe portion which gave optical activity which gave changesuch as a portion or an electrooptic effectto the heights which produce reflection of lightdispersionrefractiondiffractionabsorptiona penetrationpolarizationor a deviationthe creviceand the optical property (these) [name generically and] the following and a dot -- saying -- the formed new member being developedand the optical member arranged now on the light guide plate 2or its upper surface or undersurface[constitute and] By forming the dot concerning any at least one of the optical members arranged to the undersurface or these sides on this light guide plateIt is possible that these light guide plates 2 and an optical member also give the function of the diffusion board 5 or the condensing plate 6and it enables it to exclude these diffusion board and a condensing plate.

[0007]Howeverwhen a dot area is large in such a casethere is a problem that the phenomenon of the dot vanity whose dot is visible to group punctiform arises. Although what is necessary is just to make a dot area small so that dot vanity may not arise in order to prevent thissince a dot is arranged regularlyThe RGB matrix of a light filter and the regular pattern of TFT in the upper part or the lower part of the above-mentioned member arranged on the upper surface or the undersurface of a light guide plateand the pattern of the dot interferedandas a resultthere was a problem that moire arose.

[0008]On the other handwhen the dot had been arranged at randomgenerating of moire could be preventedbut there was a problem that unevenness will arise in dot density and the unevenness and dot vanity of luminance distribution will arise as a result. In order to prevent thisthere is a method of using a diffusion board. Howeverif a diffusion board is insertedpart mark will increaseand light transmittance will falland it will be set to one of the causes which spoil the luminosity of a display device.

[0009]The purpose of this invention is to provide the liquid crystal

display which this problem is solvedand there is neither dot vanity nor luminosity unevennessand moire does not produce.
[0010]
[Means for Solving the Problem]to achieve the above objectsthis invention -- the light guide plate surface -- and -- or the undersurface. And. Or formed light of an optical member arranged on the upper surface or the undersurface of a light guide plate reflectiondispersionrefractiondiffractionabsorptiona penetrationor in order to make it polarize or deviate. Constraints with constant arrangement of a portion which gave change to heightsa creviceor an optical propertyand a portion (henceforth a dot) which gave optical activity are fulfilledand a member which carried out arrangement formation at random is used.
[0011]
[Embodiment of the Invention]Specificallythis invention carries out arrangement formation of the dot so that one or more of the feature of following the (1) - (8) may be filled.
[0012]Feature (1): In the field of a total area by which dot formation is carried out which is not less than 99% preferably not less than 80%as shown belowcarry out arrangement formation of the dot. Namelyin the range of 3-6 in the function G (R) searched for from arrangement of all the dots which divide a dot formation side into the field of the square of 1-4-$mm^2$and exist in these square regionsR/R00 -- < -- S1/S2<0.4 -- desirable -- 0 -- < -- arrangement formation of the dot is carried out so that it may be S1/S2<0.02. At this timewhen the area of this square determines preferably that 50 or more dots are contained in [at least 20] this squareit is still more preferred. HoweverR: Value L/rootN broken by the distance from the center position of a dot to the center position of other dotsand the square root of severalN of the dot contained all over these square regions in length [of one side] L of R0:square regions about all the dot. Namelya length of one side equal to the average area of exclusive use per dot in these square regions of the square of areag (R) : The function and S1:R/R0 which are produced by taking the weighted average of the radial distribution function called for from the arrangement which is a dotand the G(R):radial distribution function g (R)and approximating using the least square method within the limits of 3-6They are a value produced by integrating R/R0 with ** G(R)-{average value of G (R)} **and a value from which S2:R/R0 is obtained by integrating R/R0 with the average value of G (R) within the limits of 3-6.
[0013]Hereradial-distribution-function g (R) is explained. Drawing 6 (a)

is a figure showing what divided the dot formation side into the square regions of 1 - $4\text{-mm}^2$and one grid is square regions. As for the area of this squareat this timeit is preferred to determine preferably that 50 or more dots are contained in [at least 20] this square. Drawing 6 (b) expands and shows the 3x3=9 piece square regions in the field A surrounded with a circle [in the figure (a)]. In each square regionsarrangement formation is carried out so that the dot shown by a black dot seal may fulfill the feature of the above (1). Hereit is shown whether the radial distribution function g (R) is called for for every dotis seen from the dot for every dotand other dots are distributed similarly.
[0014]Drawing 7 shows the distribution state of other dots seen from a certain dot Pand at least one piece assumes the existing circumference focusing on the dot P. The radius of this circumference is the distance R to the center position of other above-mentioned dotsand the six circumferencesR=r1r2r3r4r5and r6 (howeverr1<r2<r3<r4<r5<r6)are shown here.
[0015]If the number of other dots on the circumference of the radius R is set to N (R) nowthe radial distribution function g (R) is the next (several 1).
[0016]
[Equation 1]

[0017]It comes out and defines.
[0018]HereN(R)/R normalizes the number N (R) of other dots on the circumference of the radius R in this radius (namelydistance to a dot position). Thereforethe radial distribution function g (R) will be called the sum of the dot number normalized in the distance R.
[0019]Thenwhen even radius R=r6 is targeted to the dot P and it asks for the radial distribution function g (R) of the dot P at this time as mentioned above for exampleby drawing 7. At the time of R=r1at the time of N(r1) = 4 and R=r2 At the time of N(r2) =4 R=r3. At the time of N(r3) = 4 and R=r4at the time of N(r4) =8 R=r5. If it is N(r6) = 4and each dot is arranged in the shape of [at equal intervals] a lattice at the time of N(r5) = 4 and R=r6 and it is made a length of one side of a latticei.e.r1=1.00It is r2=1.41r3=2.00and r4=2.45 r5=2.82 and r6=3.00Thereforeit is N(r1)/r1=4.00 and N(r2)/r2=2.84 N(r3)/r3=2.00 and N(r4)/r4=3.26 N(r5)/r5=1.42 and N(r6)/r6=1.33. If this is shown about the radius Rthe radial distribution function g (R) will become like drawing 8 (a).

[0020]And since distribution of other dots is equal about all the dots in square regions in drawing 6 (a) when a dot is arranged regularly as shown in drawing 7the radial distribution function g (R) to all the dots is equal. Thereforethe radial distribution function g (R) of all these dots comes to be shown in drawing 8 (a).
[0021]Although a range which asks for this radial distribution function g (R)i.e.the range of the distance Ris explained laterit is seldom necessary to enlarge and the maximum to adopt is specified suitably. Although it asks for the radial distribution function g (R) about all the dots in square regionsthe range of the distance R at this time may be protruded from these square regions. For examplein drawing 6 (b)if it shall ask for this radial distribution function g (R) within the circumference B centering on this dot P when asking for the radial distribution function g (R) of the dot P in an end in a certain square regionsthis range may overflow into the next square regions.
[0022]Since arrangement relations of other dots seen from each dot differ in including random nature in arrangement of a dotthe distance R in which other dots exist for every dot will differ mutuallyand the radial distribution functions g (R) to each dot will differ. Thereforeas radial-distribution-function [in this case] g (R)as shown in drawing 8 (b)compared with regular dot arrangementalmost continuous distribution will be expressedfor example.
[0023]Drawing 9 weight averages the radial distribution function g (R) of all the dots in classified square regionsAlthough the radial distribution function G (R) produced by approximating with the least square method is shown andas for the figure (c)some regularity is maintaining a case where random nature is added to regular dot arrangement for a while in a case where a dot is arranged regularly as for drawing 9 (a) as for the figure (b)When a case where it is completely random in dot arrangement is shownrespectively and a dot is arranged regularlythe figure (d) a case where random nature is added greatlyAlthough the radial distribution function G (R) expresses completely discontinuous distributionconsidering character of radial-distribution-function g (R) explained by drawing 7 and drawing 8Becoming continuous distribution as random nature is addedin the case of completely random dot arrangementthe radial distribution function G (R) will completely express uniform distribution continuously.
[0024]Thusradial-distribution-function g (R)therefore the radial distribution function G (R) serve as an index showing a grade of the random nature of dot arrangement.
[0025]The above details are indicated to J.M.Ziman work "physics of

disorder" Maruzen Co.Ltd. (JulyShowa 57) issue pp.58-.
[0026]Nowas for the above-mentioned feature (1)the radial distribution function G (R) called for as mentioned above is R/R0 (R0). As mentioned abovewhen expressed as a function of being a constant decided by a dot number in square regionsR/R0 is 0<S1/S2<0.4 and a thing which sets up dot arrangement in all the square regions preferably within the limits of 3-6as it is 0<S1/S2<0.02.
[0027]Although S1 is a value produced by R/R0 integrating R/R0 with ** G(R)-{average value of G (R)} ** within the limits of 3-6 hereWhen the radial distribution function G (R) seems to show this in drawing 10 (a)it is the value which integrated with a portion in which R/R0 carried out hatching as a right going-up solid line in the range of 3-6. Although S2 is a value produced by R/R0 integrating R/R0 with average value of G (R) within the limits of 3-6this is the value in which R/R0 integrated a right going-down solid line in the range of 3-6 with a portion which carried out hatchingwhen the radial distribution function G (R) seems to be shown in drawing 10 (b). ThereforeS1/S2 express a rate of the amount of change of G (R) to average value of G (R)and so that clearly from explanation of drawing 9S1/S2 approach 0so that it will have appeared that random nature in dot arrangement is so large that S1/S2 are small and random nature becomes large.
[0028]Since influence of processing of a dot of lap prevention will appear in the range with small R/R0for example although mentioned later if computation time becomes long and there is a possibility of also producing an erroras a range of R/R0when this is enlarged not muchand it is made not much smallit is not desirable. For this reasonR/R0 was chosen as the range of 3-6.
[0029]When making S1/S2 smallrandom nature will be greatly added to dot arrangementand it was able to be considered as random dot arrangement which prevents moire very effectively in the above-mentioned range as a result of various examination or an experiment.
[0030]feature (2): -- a relation of G1 and G2 preferably defined below in the above-mentioned feature (1) -- G1/G2<0.95 -- arrangement formation of the dot is carried out so that it may be G1/G2<0.05 preferably. Hereit is the average value of radial-distribution-function [in within the limits of average value / of radial-distribution-function / in within the limits of R below the radius r of a circle of an area equal to an average of area of a G1:dot / G (R) /and G2:R<5xR0] G (R).
[0031]Drawing 11 shows this G1 and G2 about the radial distribution function G (R)and is set to r=R0/4. These G1/G2 show a lap between

dotsand a near degreeand a lap and a near degree become smallso that a value is small. And a dot lap was able to be effectively prevented by setting up a value of G1/G2 as mentioned above various examination and as a result of an experiment.
[0032]Feature (3) : Still more preferably in the above-mentioned feature (1) and (2)In [divide into a field of a square of 1-4 mm^2 a field in which a dot is formedand] not less than 80% of the square regionswhen the square regions are equally divided into four in a grid pattern and each is made into subregiondot density of these subregions is less than **20% of the average dot density of the square regions -- it comes outand as it isarrangement formation of the dot is carried out. It is made for luminosity unevenness of this to be lost.
[0033]Feature (4) : Still more preferably in the above (1)(2)and (3)About a size of a dotin not less than 80% of dot0.001 mm or morea diameter of circle of the same area as area of a dot carries out arrangement formation of the dot 0.15 mm or lessso that it may be 0.01 mm or more and 0.05 mm or less preferably. This prevents dot vanity.
[0034]As shown in drawing 12 (a)plane shape (shape of a dot at the time of seeing a dot formation side from the transverse plane) of a dot above and feature (1) - (4) A round shapea squareetc.When the length of a vertical dot is almost equal to a parallel direction and a light source to a light source shown in drawing 13it is especially effective arranging method. On the other handas shown in drawing 12 (b)the vertical length differs in plane shape of a dot to a parallel direction and a light source to light sourcessuch as an approximately rectangleand it is effective to arrange to a light sourceso that it may have the feature which is shown below in addition to the feature (1)when parallel length is long. An approximately rectangle means a form near a figure which has a radius of circle in a rectangular angleand a trapezoid which changed a length of one side to a rectangle including a rectangle. Drawing 12 gives a rule of thumb of dot shapeand this invention is not limited to this. The vertical length differs to such a parallel direction and a light sourceand since area of a portion which makes light to area of a dot reflected or refracted becomes largea dot with parallel length long to a light source can be easily manufactured by being able to decrease the number of dots greatly and coming.
[0035]Feature (5) : Still more preferablyas shown in drawing 14 in addition to the above-mentioned feature (1)in the range of R<Lyit is G(R) =0 substantiallyWhile those [further]as two or more peaks existed in G (R)among those at least one existed in the range of Lx>R>Ly and existed in at least one in the range of R>Lxarrangement formation of the

dot is carried out. In the case of drawing 14the 1st peak 8 of G (R) exists in the range of Lx>R>Lyand the 2nd peak 9 of G (R) exists in the range of R>Lx. Hereit is the width of a vertical dot to a light source which is shown in Lx:drawing 12 (b) and which is shown in width of a parallel dotand Ly:drawing 12 (b) to a light source.
[0036]Feature (6): Still more preferablyin the above-mentioned feature (1)(4)and (5)about a size of a dotcarry out arrangement formation of the dot so that not less than 80% of dots may be 0.05 mm<Lx<1.0mm and 0.03 mm<Ly<0.09mm. Still more preferablyarrangement formation of the dot is carried out so that it may be 0.1 mm<Lx<0.3mm and 0.03 mm<Ly<0.09mm. this time -- the above-mentioned reason -- Lx>Ly -- it is preferably referred to as Lx>Lyx2.
[0037]Feature (7) : Still more preferably in above-mentioned feature (1) - (3)In the case of a round shape as plane shape of a dot shows to drawing 12 (a) in the case of a liquid crystal display exceeding 20 cm of vertical anglesa squareetc.it is preferred that below 0.09-mm^2 carries out [more than 0.0001 mm^2] the area.
[0038]Feature (8): In the above-mentioned feature (1)it is preferred to carry out arrangement formation of the dot so that it may be substantially set to G(R) =0 in the range of R< dot diameter still more preferably.
[0039]By forming a dot with the above-mentioned featurea random dot which does not have moire and has neither dot vanity nor luminosity unevenness can be formed.
[0040]Hereone methods of opting for arrangement of such a dot include a **** method in a random number.
[0041]As a coordinates deciding method of more concrete random relocationa dot is arranged first at a lattice point which has regularityand there are some which set up position gap width of a dot from this lattice point using a random number after an appropriate time. If this method is usedrandom nature can be maintained and unevenness of dot density can be made small.
[0042]In a process determined after determining coordinatesusing a random number as a coordinates deciding method of random relocation of a dot. In order to prevent a lap of coordinates of a dotand unusual contiguityit is also effective to use the technique of redetermining coordinates over this eliminated dot using a random number which eliminated only coordinates of a dot which lapped or a near miss has producedand was newly generated after an appropriate time. Hereafterit laps and a preventing process [the technique of ****] is written.
[0043]A method of determining the whole dot coordinates is effective by

setting up a field (this is called cell) which divided the whole as a coordinates deciding method of random relocation of the above-mentioned dotopting for dot arrangement in this cell with a described methodand connecting this cell that carried out dot arrangement. In this casewhen performing a lap preventing processnot only this cell but a dot which exists in a cell which adjoins this cell lapsand it is necessary to consider it as an object of a preventing process.

[0044]When it is more convenient for dot density to fluctuate regularly or irregularly by a placea dot formation side is divided into a small regionand in order to change or equalize luminosity selectivelyarrangement formation of the dot is carried out so that it may have the above-mentioned random nature. A method of changing dot density of a cell using the describing [above] cell method is also effective.

[0045]Nexta drawing explains an embodiment of this invention. Drawing 1 is a figure in which a dot pattern shows one embodiment of a liquid crystal display by this invention it was made to fulfill the above-mentioned feature.

[0046]By this embodimenta random dot pattern which has a reflex function in a subsurface illuminator light guide plate of a color liquid crystal display is formed so that the above-mentioned feature may be fulfilledand it is shown in thing drawing 1 (b) which modeled this random dot pattern. Although light from this subsurface illuminator light guide plate will pass along a light filter by a color liquid crystal displaydrawing 1 (a) models and shows this color filter patternand this is making a regular pattern. And although drawing 1 (c) piles up and shows this random dot pattern and color filter patterninterference patternssuch as moiredo not generate it.

[0047]On the other handdrawing 2 shows a color liquid crystal display at the time of providing the conventional regular dot pattern to a subsurface illuminator light guide plateand drawing 2 (b) models and shows the regular dot pattern. If this regular dot pattern is piled up with the same color filter pattern as drawing 1 (a) shown in drawing 2 (a)as shown in drawing 2 (c)moire will occur by position gap slightly [both patterns].

[0048]Hereas a result of examining various kinds of random dot patternsa dot formation side is first divided into square regions of 1-4-mm^2. At this timewhen area of this square determines preferably that 50 or more dots are contained in [at least 20] this squareit is still more preferred. Since a value of the above R0 is usually about 25-100 micrometers when below 1-mm^2 carries out area of square regionsthere are

too few dots contained in square regionsand calculation of radial-distribution-function g (R) is difficult. When area of square regions was made more than 4-mm^2 and dot density change is performed in order to carry out Ryo Idemitsu amendment of a light guide plateexact evaluation cannot be performed but amendment of luminosity spots becomes difficult. It is still more desirable when dot density is lowand this square is preferably set that 50 or more dots are contained in [at least 20] this square.
[0049]The radial distribution function g (R) of all the dots which exist in the square regions is calculated to all classifying square regions after an appropriate timeThe radial distribution function G (R) which took that weighted average and carried out polynomial approximation with a least square method was obtainedand in this radial distribution function G (R)when R/R0 made a value of S1/S2 0.4 or more as a range of 3-6as shown in drawing 2 (c)moire occurred. And when this value of S1/S2 was 0.4 or moreit was almost equal to a case where an incidence rate of moire has arranged a dot regularlyand there was no moire preventive effect. On the other handgenerating of moire was able to be preventedwhen a value of S1/S2 was 0.4 or less and alignment was performed to some extent. In a case of 0.02 or lesseven when alignment was not performedas shown in drawing 1 (c)moire was not generated.
[0050]At this timeit is desirable for the percentage of square regions with the above-mentioned random characteristic to be not less than 99%. When the percentage of square regions which have the above-mentioned random characteristic especially is 80% or lessmoire occurs in square regions without the above-mentioned random characteristic. When 1% or more of a rate of square regions without the above-mentioned random characteristic existsthe square regions serve as spots and it is visiblebut using according to an arrangement situation etc. is also possible.
[0051]In the case of G1-/G2>0.95as shown in drawing 3a small portion and a big portion of dot density existed selectivelyand a dot lap and dot vanity were seen. On the other handsince generating of a dot lap can be controlled when G1-/G2<0.95 is useddot vanity prevention has an effect and this can be used depending on a size of a dot. When G1-/G2<0.05 is used especiallyas shown in drawing 4generating of a dot lap or dot vanity can be prevented.
[0052]When a forming face of a dot was divided into square regions of 1-4-$mm^2$the square regions were equally divided into four in a grid pattern and dot density of each subregion divided equally differed in dot density of the square regions not less than **20%luminosity unevenness

by a shade of dot density was seen. On the other handgenerating of luminosity unevenness can be suppressed by making this value **20% or less. When the number of partitions of square regions is smaller than 4an incidence rate of luminosity spots increaseswhen larger than 4regularity increases and incidence ratessuch as moireincrease.
[0053]It is made for diameters of circle (only henceforth a diameter of a dot) of the same area as area of a dot to be [in / about a size of a dot / not less than 80% of dot] 0.01 mm or more and 0.05 mm or less preferably 0.15 mm or less 0.001 mm or more. Although a dot 0.2 mm in diameter is visible with the naked eyein about 0.15 mmit cannot check easily with the naked eye. Since neither a reflector nor the refracting interface is larger enough than wavelength of lightlight cannot be made reflected and refracted in the predetermined directionwhen a diameter of a dot is 0.001 mm or less. Suitable sizes of a dot are 0.01 mm or more and 0.05 mm or less in diameter. When a diameter of a dot is 0.05 mm or lessa check with a naked eye is difficult in a dotand prevention of dot vanity is easy. Since a size of a reflective refracting interface is below half of dot sizein order to secure a size of reflection or refractionit is desirable for a diameter of a dot to be 0.01 mm or more. Since the number of dots increases remarkably when a size of a dot is 0.01 mm or lessproduction becomes difficult.
[0054]Howeverin the case of a liquid crystal display exceeding 20 cm of vertical anglesit is desirable to suppress a total dot number to 2 billion or less dots triggered by difficulty of manufacture of a metallic molda masketc. Thereforeit is preferred to make area of a dot more than 0.0001-mm^2.
[0055]As plane shape of a dot shows drawing 12 (b)when the vertical length differs to a parallel direction and a light source to a light source and the parallel length is longerArrangement formation of the dot is carried out so that the 1st peak 8 of G (R) may exist in the range of $Lx>R>Ly$ by G(R) =0 substantially in the range of $R<Ly$ as shown in drawing 14and the 2nd peak 9 of G (R) may exist in the range of $R>Lx$. Hereit is the width of a vertical dot to a light source which is shown in Lx:drawing 12 (b) and which is shown in width of a parallel dotand Ly:drawing 12 (b) to a light source.
[0056]Thusby carrying out arrangement formation of the dota lap between dots can be prevented and a suitable interval can be opened. That isa lap between dots can be thoroughly prevented by being substantially referred to as G(R) =0 in the range of $R<Ly$. By carrying out arrangement formation of the dot so that the 1st peak of G (R) may exist in the range of $Lx>R>Ly$ and the 2nd peak of G (R) may exist in the range of

R>Lxas shown in drawing 5 (a)it becomes a perpendicular direction and the dot arrangement which is horizontal and has a suitable interval individually to a light source. When a peak is [the position] below Lx and more than Ly in oneas it shows drawing 5 (b)a lap of a dot and a dot arisesand it becomes a cause of dot vanity. When a peak is [the position] R>Lx in oneas it shows drawing 5 (c)a dot and a dot space become large more than neededdot density becomes low too muchand sufficient dot density is not obtained.
[0057]About a size of a dot0.05 mm<Lx<1.0mm and 0.03 mm<Ly<0.09mm have not less than 80% of preferred dot. They are 0.1 mm<Lx<0.3mm and 0.03 mm<Ly<0.09mm still more preferably. This is because it becomes a cause of dot vanity and manufacture becomes difficult from an increase in a dot numberand difficulty of metallic mold processing in the case of not more than thiswhen a size of a dot is more than this.
[0058]About a size of a dot in above-mentioned feature (1) - (3)In the case of a round shape as plane shape of a dot shows to drawing 12 (a) in the case of a liquid crystal display exceeding 20 cm of vertical anglesa squareetc.it is preferred that below 0.09-mm^2 carries out [more than 0.0001 mm^2] the area. This is because it becomes a cause of dot vanityand a dot number increases in the case of not more than this and manufacture becomes difficult from difficulty of metallic mold processingwhen a size of a dot is more than this.
[0059]It is [in / still more preferably / the above-mentioned feature (1)] R< dot diameter. It is preferred to carry out arrangement formation of the dot so that it may be substantially set to G(R) =0 in the range. This is for preventing a dot lap thoroughly and raising efficiency of a dot.
[0060]Nexta method of determining coordinates of a dot in this invention is explained concretely. Methods of forming a dot of random relocation include a way a manual determines coordinates of each of dots. howeversince many dots are requiredit is alike occasionallyit carries outa lap and unevenness of a dot ariseand there is a problem that correcting this takes time and effort. The regularity of dot arrangement was abolished and the following techniques were created as an efficient deciding method of coordinates (xy) of the so-called dot for arranging at random.
[0061]Technique (1): Generate a random number using a random number generation function built in a computer etc.and determine a number obtained by this as coordinates (xy) of random relocation.
[0062]Technique (2) : Regular intervals or an interval forms in x and a y direction a straight line and a curve which increase or decrease

regularlyCoordinates (xy) of a dot of random relocation are searched for by adding the amount of gaps from a lattice point using a random number (xryr) which appoints those intersections at a lattice point (X0Y0)next might be generated by random number generator. This method can show coordinates (xy) with a following formula.
x=X0+xry=X0+yr.
[0063]Technique (3): Define beforehand coordinates of two or more random dots with comparatively few numbersmake this into a dot groupand arrange this dot group at random to member surfaces. Coordinates representing a dot groupfor examplethe center coordinatesare specifically defined based on a random number obtained using a random number generatorand a dot group is arranged on the above-mentioned coordinates.
[0064]Technique (4) : by setting up a small region (henceforth a cell) which divided the whole dot formation sideopting for dot arrangement in these cells from above-mentioned (1) - (2)and connecting a cell by which dot arrangement was carried out by doing in this wayThe whole dot coordinates (xy) are determined and coordinates (xy) of a dot of random relocation are searched for.
[0065]Technique (5) : after determining coordinates using a technique (1)in a process to determine. In order to prevent a lap of coordinates of a dotand unusual contiguityonly coordinates of a dot which lapped or a near miss has produced are eliminatedand coordinates over this eliminated dot are redetermined using a random number newly generated after an appropriate time. It laps and a preventing process [the following techniques] is written.
[0066]Technique (6): There is also a method of combining the technique (1)(4)and (5). That isa method of determining the whole dot coordinates is effective by setting up a cellopting for dot arrangement in this cell with the described method (1) and (5)and connecting this cell that carried out dot arrangement. In this casenot only this cell but a dot which exists in a cell which adjoins this cell lapsand it is necessary to make a lap preventing process into an object of a preventing process.
[0067]Technique (7): In order to change or equalize luminosity selectivelywhen it is more convenient for dot density to fluctuate regularly or irregularly by a placedivide a dot formation side into a cell and carry out arrangement formation of the dot using a technique (6).
[0068]A technique explained above and the technique of having combined them are the efficient embodiment methods of this invention.
[0069]Nextthis embodiment is described still more concretely. Firsta coordinates evolution method of a dot which has the feature of said

feature (1) - (8) is explained. Drawing 6 is a figure expanding and showing a part of dot formation side by this embodiment of a light guide plate used for a subsurface illuminator of a liquid crystal display element. In the figurea dot is a circular dot whose size the average lattice spacing is 50 micrometers in diameter in 100 micrometers. A value of x which opts for arrangement of a dotand a y-coordinate is determined using a random numberand is performing a lap preventing process.
[0070]When 10000 dots were formed in 1-cm^2 with a lattice spacing of 100 micrometers2 sets of random numbers of 4 figures were generated 10000 times using a computerrespectivelyone side was made into an x-coordinate andspecificallya dot position was defined by making another side into a y-coordinate. Thusa formed dot may cause dot vanitywhen dots lapped depending on the casea dot stands in a row and it becomes one big dotwhen extremeand this member is applied to a liquid crystal display element.
[0071]In order to prevent such evil beforehanda lap preventing process is performed. With a lap preventing processcoordinate data obtained on the occasion of calculation of dot coordinates is accumulated in a memoryAfter calculating the following coordinateswhen coordinates of a dot approach too much with them as compared with the past data (usually although it is a case where distance of the center coordinates of a dot is twice [one to / less than] the diameter of a dot) It is not a thing to limit to this but the technique of recalculating coordinates by regenerating a random number again in consideration of a size and density of a dot to choose a suitable value. If this technique is useda dot lap and approach can be prevented.
[0072]Drawing 15 (a) is a lineblock diagram showing a system for itand is constituted by a main part of a personal computer (PC)a displayand keyboard. And coordinates of each dot are determined by generating a random number from a personal computer.
[0073]Drawing 15 (b) is a flow chart which shows operation of this systemJudge whether it laps with these coordinates it is going to set up among dots of already set-up coordinatesor some are above nearwhenever it is going to set up coordinates of a dot using a random numberif there is nothingwill carry out a coordinate setbut. If it isthis will be canceleda random number will be generated again and the same operation will be repeated.
[0074]Drawing 16 is a figure showing one example of a coordinates deciding method of random relocation of a dot in this embodiment. Firstas are shown in drawing 16 (a)and a lattice point set up regularly

is made into an arranging point of a dot and it is shown in drawing 16 (b) in which a portion of C of drawing 16 (a) is expanded and shown for each lattice point of every after an appropriate timex from that lattice point (xy) and position gap width of a y direction are set up at random using a random numberand only this position gap width makes a position of a dot position [lattice point] (X'Y') shifted. A position of this dot is a position of the center of a dotand shows a dot by which random relocation was carried out by ** at drawing 16 (a). This technique is effective as a method of preventing a lap of a dot beforehand. In this methoda dot is arranged beforehand at a lattice pointit shifts from a lattice pointquantity is defined as the amount of displacement of a x direction and a y directionand the above-mentioned amount of displacement is determined using a random number. The amount of displacement of x and y can be calculated at the maximum of the amount of amount of displacement = {surplus which **(ed) random number of integer of 4 or more figures by (maximum x2+1 of amount of displacement)}-displacement of a maximum y direction of a following formula of amount of displacement = {surplus which **(ed) random number of integer of 4 or more figures by (maximum x2+1 of amount of displacement)}-displacementi.e.the amount of a x direction. Dot center coordinates (X'Y') of random dot arrangement are shown by lower type in drawing 12 (b).
the amount of displacement of a X 'amount Y of displacement of =X1+ x direction' =Y1+ y direction -- herethe maximum of the amount of displacement can be chosen according to a use. Random nature becomes largeso that the maximum of the amount of displacement is large. Howeversince a lap also increasesconsideration of performing a dot lap preventing process is needed. Herethe maximum of displacement shall be 50 micrometers and concrete example computation in a case of calculating the amount of displacement of a x direction is shown below. In this casea random number of 4 or more figures is generated first. Suppose that "28469" occurred as the example. In this casesince it is maximum x2+1=101 of the amount of displacementit is 28469/101=281 and the remainder 88and is set to amount =of displacement88-50=33micrometer of a x direction.
[0075]Drawing 17 shows a case where a dot formation side (220 mm x 180 mm) is classified into a cell with a square of 10 mm x 10 mmand drawing 18 (a) is the field C in drawing 17i.e.a figure expanding and showing one cell. Drawing 18 (b) is a figure expanding and showing some fields D of drawing 18 (a).
[0076]Hereas shown in drawing 18 (b)random relocation of the dot of

rectangular shape whose length of one side is 50 micrometers shall be carried out with a lattice spacing of 100 micrometersIt is the method of forming random dot arrangement for determining the whole dot coordinates (xy) by carrying out random relocation of the dot as mentioned above for every celland connecting these cells after an appropriate time.

[0077]In this forming methodsince the dot number inside a cell is constantwhen it watches on the wholethe feature is that it can form dot arrangement of uniform density.

[0078]Nextas shown in drawing 14 in addition to the feature (5)(1)i.e.the featurein the range of R<Lysubstantially by G(R) =0. An evolution method of center coordinates of a dot in a case of carrying out arrangement formation of the dot so that the 1st peak 8 of G (R) may exist in the range of Lx>R>Ly and the 2nd peak 9 of G (R) may exist in the range of R>Lx is explained.

[0079]Firstconstant KS1 which fills Ly<KS1<Lx and Lx<KS2and KS2 are defined in consideration of a size and density of a dot. Nextwhat is necessary is to consider that it is near-missingto lap and just to perform a preventing processwhen fulfilling conditions of both ingredient <KS1 of a perpendicular direction to a light source of distance of distance between horizontal ingredient <KS2 and a dot to a light source of distance between dots.

[0080]As dot arrangement shown in drawing 18with the above-mentioned technique (2)the next (table 1) forms a random dot of 10000 dot density [/cm] ^{2}and The maximum of the amount of displacementand the characteristic of radial-distribution-function G (R)A result of having examined moirea dot lapdot vanityand luminosity unevenness of an obtained member is summarized.

[0081]

[Table 1]

[0082]The maximum of the amount of displacement of a dot from the above-mentioned lattice point that it is 10 micrometers or less the radial distribution function G (R). As shown in drawing 19 (the maximum of the amount of displacement = 5 micrometers)or drawing 20 (the maximum of the amount of displacement = 10 micrometers)strong periodicity is seenit interferes with a pattern which was a rule of a TFT formed pattern of a liquid crystal display elementor a light filterand moire as shown in drawing 2 arises.

[0083]On the other handif the maximum of the amount of displacement of the dot from a lattice point shall be 20 micrometers (drawing 21) or 30

micrometers (drawing 22)periodicity will be looked at by the radial distribution function G (R)but generating of moire can be prevented to some extent. Neither a dot lap nor dot vanity is produced in this case.
[0084]When the maximum of the amount of displacement of the dot from a lattice point shall be 50 micrometers (drawing 23)80 micrometers (drawing 24)or 100 micrometers (drawing 25)periodicity stops almost appearing in the radial distribution function G (R). For this reasongenerating of moire can be prevented nearly thoroughly. Howeverwhen the maximum of the amount of displacement shall be not less than 50 micrometersthere is no generating of moirebut the case where the probability of a dot lap becomes large and dot vanity arises comes to happen. Thena dot lap can be preventedlosing the periodicity of radial-distribution-function G (R)as shown in drawing 26if it restricts by lapping further. In this casealthough the peak of the 1st contiguity dot of R/R0=1/2 appearsthis does not cause moire. For this reasonmoire and dot vanity serve as dot arrangement removed good.
[0085]The next (table 2) is an examining result at the time of performing dot arrangement shown in drawing 18 with the above-mentioned technique (1)i.e.the absolute random number arranging method which arranges all the dots by random numbers using a random number generator. In this caseif lap restrictions are not carried outthe probability that a dot lap will increase and dot vanity will arise is high. Howevera pattern without dot vanity is obtained by performing lap restrictions.
[0086]
[Table 2]

[0087]Nextthe concrete application to the member of this embodiment is explained. Drawing 27 is what shows one example of the subsurface illuminator in the embodiment by this inventiona whole perspective view and the figure (b) of the figure (a) are sectional views seen from dividing-lines Z-Z of the figure (a) -- 1 -- a light source and 10 -- as for waveguide light and 14a film (or plate) and 12 are [a light transmission surface and 16] small heights (dot) emitted light and 15 the undersurface of the light guide plate 2and 13 incident light and 11.
[0088]In the figure (a) and (b)as the small heights (dot) 16 which make approximately cone type explained to the undersurface 12 of the light guide plate 2 previouslythey are arranged at random on it.
[0089]Although the incident light 10 from the light source 1 enters into the light guide plate 2 from the drawing top left side end side of the light guide plate 2turns into the waveguide light 13 and it goes to the

end face of another side of the light guide plate 2this waveguide light 13 advances repeating total internal reflection in the undersurface 12 and the light transmission surface 15 of a light guide plate. It reflects on a slant faceand the light which entered into the inclined plane of the smallness heights 16 among this waveguide light 13 strikes upon the light transmission surface 15is refracted thereand is emitted from the light transmission surface 15. The emitted light 14 of this light guide plate 2 enters into the liquid crystal display element which is not illustrated as illumination light.

[0090]Hereby arranging properly the small heights 16 and the light reflector 4 in the undersurface 12 of the light guide plate 2the waveguide light 13 can be gradually emitted from a light guide plateand a liquid crystal display element can be illuminated. At this embodimentalthough control of emitting angle degree distribution of the illumination light becomes easier and small heights are arranged at random by formation of small heights thereforethere is no generating of moire.

[0091]Since the light intensity from a light source falls as it generally keeps away from a light source within a light guide plateit changes the densityheightor size of the small heights 16 according to itand it is made for the intensity distribution of the catoptric light in small heightsi.e.luminosityto become uniform over the whole undersurface surface of a light guide plate. Thereforesmall heightsi.e.the density of a dotare good to form so that it may increase toward the end face of another side of the light guide plate which faces from the light source side edge of a light guide plate.

[0092]What is necessary is to divide the undersurface of a light guide plate 16 in the shape of a strip of paperfor exampleto ask for proper dot density beforehand for each [which was divided] field of every as a formation method of the dot in such a caseand just to carry out dot arrangement at random according to the dot number for each field of every. That iswhen dot density (numerousness of dot numbers) is fluctuating regularly or irregularly when the whole dot formation side is seenand it limits to the small region of the dot formation side of the light guide plate 2a dot is arranged at random using a random number. Thusthe formed light guide plate does not have moire generatingand the characteristic which was excellent in homogeneity also about luminance distribution is shown. The method of setting up a cell small and changing dot density continuously is also effective.

[0093]Drawing 28 is what shows other examples of the subsurface illuminator in the embodiment by this inventionThe perspective view

which looked at the figure (a) from the upper surface slant sidethe perspective view which looked at the figure (b) from the undersurface slant sideand the figure (c) are sectional views in alignment with dividing-lines Z-Z of the figure (a)16 is small heights (dot) and 17 is an inclination of a dot. The explanation which attaches identical codes to the portion corresponding to drawing 27and overlaps is omitted.
[0094]In drawing 28they are the light source 1the light guide plate 2and a film (.) at this example. Or the plate 11 is made into the minimum configuration elementand the small heights 16 are arranged at random as mentioned above to the field by the side of the light guide plate 2 of the film (or plate) 11 provided in the light transmission surface 15 side of a light guide plate. Optical coupling of the light guide plate 2 and the film (or plate) 11 is carried out at the flat surface of the tip part of the small heights 16.
[0095]In drawing 28 (c)the light source 1 to the incident light 10 enters into the light guide plate 2 from the left side end side of the light guide plate 2and goes to the end face of another side as the waveguide light 13. It goes on at this timerepeating total internal reflection in the undersurface 12 and the light transmission surface 15 of the light guide plate 2. Waves are guided in the film (or plate) 11and it reflects on the side 18 of the small heights 16and the light which entered into the joined part with the small heights 16 of the film (or plate) 11 among the waveguide light 13 is emittedand turns into illumination light of the liquid crystal display element which is not illustrated from the film (or plate) 11.
[0096]Hereby rationalizing the size of the small heights 16surface densityand the angle of inclination of the side 18the waveguide light 13 is made to emit from the light guide plate 2 graduallyand a liquid crystal display element can be illuminated almost uniformly from the light transmission surface 15 whole surface of the light guide plate 2.
[0097]Also in this examplecontrol of emitting angle degree distribution of the illumination light becomes easier by formation of the small heights 16and although the small heights 16 are arranged at random thereforethere is no moire generating.
[0098]Drawing 29 is a top view for which the example of the light guide plate 2 manufactured by the conventional dot formation method is shownas for the figure (a)a dot makes conical shapethe figure (b) makes eight-sided pyramidsand these dots are making regular arrangement (refer to JP6-67004A). In such a casethere is a tendency which moire produces.
[0099]Nextthe shape of the dot in this embodiment is explained. Dot shape in particular is not limited. As shape of a dotalthough a

rectangle and a cone are foundationsas shown in multiple weightssuch as eight-sided a pyramid as shown in drawing 30 (a) as a perspective viewhexagon-head weighta pyramidetc. and drawing 30 (b) as a front viewthe shape made to transform them or longwiseoblong and slanting arrangementetc. are effective.

[0100]Drawing 31 shows one another example of the subsurface illuminator in the embodiment by this invention. The perspective view which looked at the figure (a) from the upper surface slant sideand the figure (b) are sectional views in alignment with dividing-lines Z-Z of the figure (a). Drawing 32 is a shape explanatory view of the dot (small crevice) of this example. 19 is a small crevice (dot) and 20 is an inclination of a dot.

[0101]In drawing 31by this examplethe light source 1the light guide plate 2and the light reflector 4 are made into the minimum configuration elementand drawing 31 (b) shows the beam-of-light locus of the waveguide light 13 which advances the inside of the light guide plate of this example. In drawing 31 (b)the light from a light source enters into the light guide plate 2 as the incident light 10 by a light guide plate light source side edgeturns into the waveguide light 13and it advances toward the end face of another siderepeating total internal reflection in the light guide plate undersurface 12 and the light transmission surface 15. It reflectsand the light 21 which entered into the smallness crevice inclined plane 20 among waveguide light strikes upon the light transmission surface 15is refracted thereis emitted as emitted light and turns into illumination light of the liquid crystal display element which is not illustrated from a light transmission surface.

[0102]And the light which was not reflected turns into the dot slant-face transmitted light 22it reflects with the light reflector 4and enters into a light guide plate againthe part is emitted from a light transmission surfaceand the remainder serves as waveguide light again. Thereforeby arranging a dot properlywaveguide light can be made to be able to emit from a light guide plate graduallyand a liquid crystal display element can be illuminated. The angular distribution of the emitted light from controlling a section angle of gradient properly and a light guide plate is controllable.

[0103]Also in this examplecontrol of emitting angle degree distribution of the illumination light becomes easier by formation of the small crevice 19and although the small heights 19 are arranged at random thereforethere is no moire generating.

[0104]Drawing 32 is a figure showing the dot shape of this example. In this examplethe plane shape of a dot is an approximately rectanglethe

vertical length differs to a parallel direction and a light source to a light sourceand parallel length is long to a light source. Thenin addition to the feature (1)in the range of R<Lya random dot is G(R) =0 substantiallyas shown in drawing 14and it carried out arrangement formation of the dot so that the 1st peak of G (R) might exist in the range of Lx>R>Ly and the 2nd peak of G (R) might exist in the range of R>Lx.

[0105]Thusthe formed light guide plate does not have moire generatingand the characteristic which was excellent in homogeneity also about luminance distribution is shown.

[0106]Nextother matters are explained briefly. As a member which constitutes the material which forms a dotand various liquid crystal displaysthe transparent plastic material which is a light guide plate and a charge of various function nature film material is common. As an examplethere are an acrylic plasticpolycarbonate resinpolyesterpolyacetal resinpolyurethane system resinultraviolet curing type plastic materialetc. Before longan acrylic material is excellent in respect of transparencythe priceand the moldabilityand is a material suitable for this invention. Howeverthis invention is not limited to this material.

[0107]Not only in that which makes concave and the shape of heights and in which light is reflected as mentioned above as a dotIt is good also as a dot which gave optical activitysuch as a dot which may make it polarize or deviate and gave [dispersionrefractiondiffractionabsorptiona penetrationor] change to the optical propertyor an electrooptic effect. For examplewhile light advances a light guide plate in the case of a dot with dispersion natureit will be scattered about little by little and light will be uniformly irradiated by this by this dot over the whole surface of a liquid crystal cell.

[0108]Drawing 33 is a sectional view showing the composition of the conventional subsurface illuminator of a liquid crystal displayand 1 is a condensing plate for a light scattering layer and 4 to condense a light reflectorfor 5 condense sixand for a light guide plate and 3 make lightas for a diffusion board and 7condense [2 / a light source and]. Application also to this subsurface illuminator is possible for this inventionand it can provide a random dot pattern in the light scattering layer 3the light reflector 4the diffusion board 5the condensing plates 6 and 7etc.

[0109]Drawing 34 is a figure showing the entire configuration of a liquid crystal displayand the light guide plate 2the diffusion board

5the optical condensing plates 6 and 7the polarizing plate 23the liquid crystal cell 24the common electrode 25the light filter 26the polarizing plate 27the angle-of-visibility expansion sheet 28etc. are formedArrangement of the dot of this invention is applicable to the optical condensing plates 6 and 7the polarizing plates 29 and 30the angle-of-visibility expansion sheet 31etc.

[0110]About the liquid crystal element and liquid crystal cell which are used for this inventionthere is no limitation in particular and a publicly known element and a panel can be used. As a general liquid crystal cella twist pneumatic moldsuper twist pneumatic moldhomogeneous typeand thin film transistor type thingan active-matrix drive typea simple-matrix-driving type thingetc. are mentioned.

[0111]

[Effect of the Invention]According to this inventionas explained abovesince it is arranged as the random nature to which a dot is specified is maintainedinterference with a regularity pattern can be preventedand generating of moire can be oppressed effectivelyand dot vanity can be lost.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a figure showing the random dot pattern in a 1st embodiment of the liquid crystal display by this inventionand an effect when a filter pattern is piled up for it.

[Drawing 2]It is a figure showing a phenomenon when a conventional regularity dot pattern and filter pattern are piled up.

[Drawing 3]It is a figure showing a random dot pattern without the lap preventing process in a 1st embodiment of the liquid crystal display by this invention.

[Drawing 4]It is a figure showing the random dot pattern which made the lap preventing process in a 1st embodiment of the liquid crystal display by this invention.

[Drawing 5]It is a figure explaining the random dot pattern which made the lap preventing process in the rectangle dot of the liquid crystal display by this invention.

[Drawing 6]It is a figure for explaining the range which asks for the radial distribution function g (R) of the dot in the square regions which classified the dot formation side in a 1st embodiment of the liquid crystal display by this inventionand these square regions.

[Drawing 7]It is a figure explaining how to ask for the radial distribution function g (R) of a dot.
[Drawing 8]It is a figure showing the example of radial-distribution-function [in a regularity dot pattern and a random nature dot pattern] g (R).
[Drawing 9]It is a figure showing the example according to the size of the random nature of the dot pattern of radial-distribution-function G (R) for which it asked from radial-distribution-function g (R).
[Drawing 10]It is a figure for explaining the integral value S1 about the radial distribution function G (R)and S2.
[Drawing 11]It is a figure for explaining the average value G1 about the radial distribution function G (R)and G2.
[Drawing 12]It is a figure for explaining the plane shape of a dot.
[Drawing 13]It is a figure for explaining the direction of coordinates.
[Drawing 14]It is a figure for explaining the radial distribution function G (R) in case the shape of a dot is an approximately rectangle.
[Drawing 15]It is a figure showing one example and operation of a random dot-data manufacturing device.
[Drawing 16]It is a figure showing one example of the creation technique of the random dot pattern in a 1st embodiment of the liquid crystal display by this invention.
[Drawing 17]It is a top view showing the cell in respect of the dot formation in a 1st embodiment of the liquid crystal display by this invention.
[Drawing 18]It is a top view expanding and showing 1 cell part by drawing 14.
[Drawing 19]They are graph charts showing the example of radial-distribution-function [when the maximum of displacement of the position coordinate of the dot from the lattice point of a regularity lattice pattern is 5 micrometers] G (R).
[Drawing 20]They are graph charts showing the example of radial-distribution-function [when the maximum of displacement of the position coordinate of the dot from the lattice point of a regularity lattice pattern is 10 micrometers] G (R).
[Drawing 21]They are graph charts showing the example of radial-distribution-function [when the maximum of displacement of the position coordinate of the dot from the lattice point of a regularity lattice pattern is 20 micrometers] G (R).
[Drawing 22]They are graph charts showing the example of radial-distribution-function [when the maximum of displacement of the position coordinate of the dot from the lattice point of a regularity lattice

pattern is 30 micrometers] G (R).
[Drawing 23]They are graph charts showing the example of radial-distribution-function [when the maximum of displacement of the position coordinate of the dot from the lattice point of a regularity lattice pattern is 50 micrometers] G (R).
[Drawing 24]They are graph charts showing the example of radial-distribution-function [when the maximum of displacement of the position coordinate of the dot from the lattice point of a regularity lattice pattern is 80 micrometers] G (R).
[Drawing 25]They are graph charts setting the maximum of displacement of the position coordinate of the dot from the lattice point of a regularity lattice pattern to 100 micrometers and in which showing the example of radial-distribution-function [when you have no lap preventing process] G (R).
[Drawing 26]They are graph charts setting the maximum of displacement of the position coordinate of the dot from the lattice point of a regularity lattice pattern to 100 micrometers and in which showing the example of radial-distribution-function [at the time with a lap preventing process] G (R).
[Drawing 27]It is a figure showing one example of the subsurface illuminator in a 1st embodiment of the liquid crystal display by this invention.
[Drawing 28]It is a figure showing other examples of the subsurface illuminator in a 1st embodiment of the liquid crystal display by this invention.
[Drawing 29]It is a figure showing the conventional regular dot pattern in the subsurface illuminator of a liquid crystal display.
[Drawing 30]It is a figure showing the example of the shape of the dot in a 1st embodiment of the liquid crystal display by this invention.
[Drawing 31]It is a figure showing other examples of the subsurface illuminator of the liquid crystal display by this invention.
[Drawing 32]It is a figure showing the dot shape of other examples of the subsurface illuminator of the liquid crystal display by this invention.
[Drawing 33]It is a sectional view showing the example of the subsurface illuminator of the conventional liquid crystal display.
[Drawing 34]It is a sectional view showing the entire configuration of a liquid crystal display.
[Description of Notations]
1 Light source
2 Light guide plate

3 Light scattering layer
4 Light reflector
5 Diffusion board
6 Condensing plate
7 Condensing plate
8 The 1st peak of G (R)
9 The 2nd peak of G (R)
10 Incident light
11 Film (or plate)
12 Light guide plate undersurface
13 Waveguide light
14 Emitted light
15 Light transmission surface
16 Small heights (dot)
17 Inclined plane
18 Side
19 Small crevice
20 Small crevice slant face
21 Light which entered into the small crevice slant face
22 Dot slant-face transmitted light
23 Polarizing plate
24 Liquid crystal cell
25 Common electrode
26 Light filter
27 Polarizing plate
28 Angle-of-visibility expansion sheet
29 Polarizing plate
30 Polarizing plate
31 Angle-of-visibility expansion sheet